CRM 96-63 / December 1996

Analysis of DoD's Commercial Activities Program

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REPORT DOCUMENTATION PAGE			Form Approved OMB No. 074-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	December 1996	Final

4. TITLE AND SUBTITLE
Analysis of DOD's Commercial Activities Program

5. FUNDING NUMBERS
C - N00014-96-D-0001

6. AUTHOR(S)
RD Trunkey, RP Trost CM Snyder

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Center for Naval Analyses
4401 Ford Avenue
Alexandria, Virginia 22302-1498

8. PERFORMING ORGANIZATION REPORT NUMBER
CRM 96-63

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 Words)***
In 1955, the Office of Management and Budget (OMB) implemented a policy known as the Commercial Activities (CA) Program. This program enables the private sector to compete with government organizations in providing goods and services when it is appropriate and economical to do so. The objective is to promote an efficient support structure through competition. This research memorandum is part of a CNA-initiated research effort examining the DoD Commercial Activities program. Most of our previous research has examined the Navy CA program. This paper presents the results of all completed DoD comprehensive A-76 competitions between 1978 and 1994.

14. SUBJECT TERMS
competition, contract administration, contract proposals, contractors, costs, defens4e economics, Department of Defense, mathematical models, outsourcing

15. NUMBER OF PAGES
49

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

Contents

Summary

This research memorandum is part of a CNA-initiated research effort examining the DoD Commercial Activities (CA) program. Most of our previous research has examined the Navy CA program [1, 2]. This paper presents the results of all completed DoD comprehensive A-76 competitions between 1978 and 1994.

Our results are consistent with previous CNA analyses of the Navy CA program and with other studies of public-private competitions [3 through 6]. There are two companion documents: CIM 471 [7] which documents our examination of the CA Inventory data and CIM 472 [8] which documents our examination of the CA Competition data. These documents contain more details on our analysis of the respective data sets as well as suggestions for improving data collection in the future.

The results of this project answer the following questions:

- What are the results of previous CA competitions in DoD?
- Are there differences in the study completion rate across military services/agencies?
- Are there differences in savings across services/agencies?
- Are there differences in savings across functions?
- What characteristics of competitions are associated with high savings and what characteristics are associated with low savings?
- What level of savings can DoD expect from additional CA competitions?
- What improvements can be made to the existing tracking process for the CA program?

Answering these questions will allow the Navy and DoD to learn from the experience of all services in competing CA functions. The Navy and DoD can use our results to:

- Target certain functions with high potential savings
- Modify the process for functions with low savings in the past
- Monitor studies that have high historic cancellation rates
- Look for new competition candidates.

Past A-76 competitions have yielded significant savings. Total annual savings from previous competitions amount to about $1.5 billion annually or about 30 percent of the baseline cost of performing the functions. The savings seem to result from competition rather than outsourcing per se.[1] Most of the completed competitions were small: 73 percent had 25 or fewer civilian and military billets.

We found that in general the following characteristics are associated with high savings:

- Large single-function competitions
- Functions performed primarily by military personnel
- Research (RDT&E) support
- Real property maintenance functions
- Installation services
- Intermediate maintenance.

In addition, we found that small competitions were more likely to produce no savings while large competitions were more likely to be canceled. Overall, 41 percent of initiated studies were canceled. We found no significant correlation between the probability of cancellation and the probability of zero savings, meaning that the canceled studies have the same potential for positive savings as the completed studies.[2]

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1. This is supported by an examination of the bids and by the fact that the in-house team won approximately half of the competitions.

2. This result comes from a bivariate probit model of cancellation and zero savings which was estimated during our model selection process.

The 1995 CA Inventory contains about 389,000 military and civilian billets. We estimate that competing all of these billets could generate about $6.2 billion worth of annual savings for DoD. There are many potential obstacles to realizing these savings including legal restrictions beyond the control of DoD. Two such restrictions are the 60/40 depot maintenance rule and the restriction on competing guards and firefighters.

On the other hand, DoD does have control over reclassifying CA billets so that they can be competed, and DoD can also exert influence on the likelihood that studies are completed. Savings will be less than $6.2 billion if CA functions are exempted from competition or if studies are not completed. For example, the $6.2 billion in potential savings could shrink to $2.9 billion if we see the same pattern of study cancellations as in the past.

However, potential savings could also be larger than $6.2 billion. The CA inventory currently includes only about 29 percent of all DoD civilians and 9 percent of DoD military billets. With 24 percent of its employment classified as CA, the Navy has classified billets as CA more aggressively than the other services. If the other services also classified 24 percent of their total employment as CA, total potential savings could rise to about $11 billion.[3]

3. See [9] for more details of this calculation.

Background

In 1955, the Office of Management and Budget (OMB) implemented a policy known as the Commercial Activities (CA) Program [10 through 14].[4] This program enables the private sector to compete with government organizations in providing goods and services when it is appropriate and economical to do so. The objective is to promote an efficient support structure through competition.

As part of the program, DoD (and each service) must inventory all commercial type functions performed within DoD. For each function at each installation, DoD must:

- Allow the private sector to compete for the work or
- Give a compelling reason why this is not feasible.

DoD can choose the type of competition it uses for the CA program, as long as it follows the guidelines in Circular A-76. The guidelines depend on activity size and are set so that smaller activities require less formal procedures and fewer reporting requirements. The specific guidelines include the following:

- If an activity has more than 45 civilians, DoD is required to perform a formal-comprehensive A-76 cost comparison before contracting out the work.[5]
- If an activity has between 11 and 45 civilians, DoD is required to perform a simplified cost comparison.

4. In 1955, the issuing organization was known as the Bureau of the Budget.
5. There are exceptions described in DoD Instruction 4100.33. Some of these guidelines were changed in the 1996 revision of Circular A-76.

- If a function has fewer than 11 civilians, the commanding officer may decide to directly convert the work to contractor performance.

Often, even the small functions are (by choice) competed as comprehensive A-76 cost comparisons. This decision may be made by the local commanding officer to avoid disputes, directed by DoD policies, or directed by Congress in the DoD appropriations bill.

As a result of the CA program, DoD initiated 4,311 A-76 competitions from 1978 to 1994 and completed 2,195 competitions. It also initiated 807 simplified cost comparisons or direct conversions. These competitions covered CA functions which are commonly performed in the private sector. This paper will focus on the results of the comprehensive A-76 cost competitions.

The A-76 process

Figure 1 depicts the process of examining a commercial activity for a comprehensive competition.[6]

The CA function is examined and one of four decisions is made:

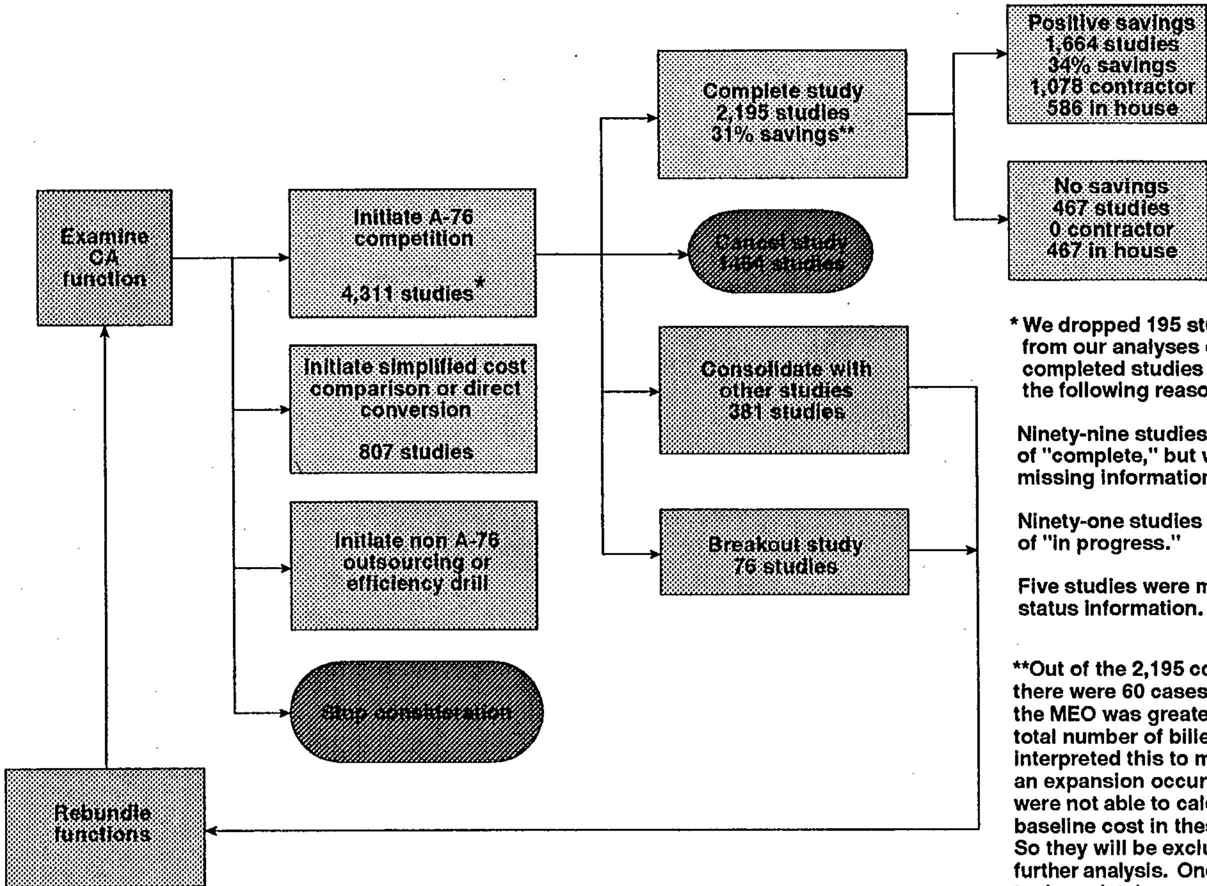
- Initiate a full comprehensive A-76 competition
- Initiate a simplified cost comparison or direct conversion
- Initiate a non-A-76 outsourcing or efficiency drill
- Completely stop consideration of function.

In a full cost comparison A-76 competition, the study is either completed, consolidated, broken into smaller studies (broken out), or canceled (figure 1). In the completed studies, the function is either contracted out or retained in-house. The studies that are broken out or consolidated are rebundled to be examined as CA studies at a later time.[7]

6. Our data source is the 1978 to 1994 DoD CA Competition data. The savings are based on our estimate explained later.

7. We considered these rebundled studies to be false starts rather than cancellations and dropped them from further analysis. See [8] for a summary of the rebundled studies.

Figure 1. The comprehensive A-76 competition process



* We dropped 195 studies from our analyses of completed studies for the following reasons:

Ninety-nine studies had status of "complete," but were missing information.

Ninety-one studies had status of "in progress."

Five studies were missing status information.

**Out of the 2,195 completed, there were 60 cases in which the MEO was greater than the total number of billets. We interpreted this to mean that an expansion occurred. We were not able to calculate the baseline cost in these cases. So they will be excluded from further analysis. One apparent typing mistake was also dropped as were three cases in which the contractor won; but the contractor's bid was larger than the in-house bid.

Steps in an A-76 competition

The actual completion of an A-76 study has many steps including:

1. Making an announcement to Congress of the intended study.
2. Writing a Performance Work Statement (PWS).
3. Creating an in-house bid (including an MEO).
4. Soliciting contractor bids.
5. Comparing bids and deciding on a winner.[8]
6. Transitioning to the MEO or to contractor performance. (This may require changes in personnel and/or shifting money from one budget account to another.)

A representative A-76 study would take about 2 years, but some have taken as long as 8 years to complete.

Savings from previous A-76 competitions

Savings by military service

Annual savings are calculated as the difference between the baseline cost of performing the function in-house and the winning bid. The baseline costs are estimated by assuming that the difference between the baseline costs and the in-house bids is proportional to the change in personnel from the baseline to the MEO—"most efficient organization." For example, if the MEO uses 20 percent fewer personnel than the baseline, then the baseline costs are assumed to be 25 percent greater than the in-house bid. For easy interpretation, all savings were converted to annual FY 1996 dollars.

Table 1 summarizes the results of past completed A-76 competitions. It shows that on average DoD has seen a 31-percent savings for all

8. Virtually all of the A-76 competitions during this time period were decided on a cost basis (lowest bidder wins). The in-house team is given a 10-percent cost advantage—meaning that a contractor must bid at least 10 percent less than the in-house team to win.

comprehensive cost competitions between 1978 and 1994. More than 82,000 billets[9] have been competed. Overall, nearly 80 percent of the billets competed were civilian. The total savings from these competitions amounts to about $1.5 billion annually.

Table 1. Summary of savings from A-76 competitions by military service

Military service or agency	Completed competitions	Contractor wins	Baseline civilians	Baseline military	Annual[a] savings	Percentage savings
DoD agencies	54	54%	1,566	5	17	22%
Army	466	48%	21,530	3,728	443	28%
Air Force	760	60%	18,147	8,633	571	36%
Marine Corps	44	41%	1,291	157	25	31%
Navy	807	43%	20,793	4,821	413	30%
Total	2,131	51%	63,327	17,344	1,470	31%

a. In millions of FY 1996 dollars.

The in-house team won about half the competitions. Assuming that the cost comparisons are done accurately, this means that competition produces the savings and not outsourcing per se.[10]

Difference in bids

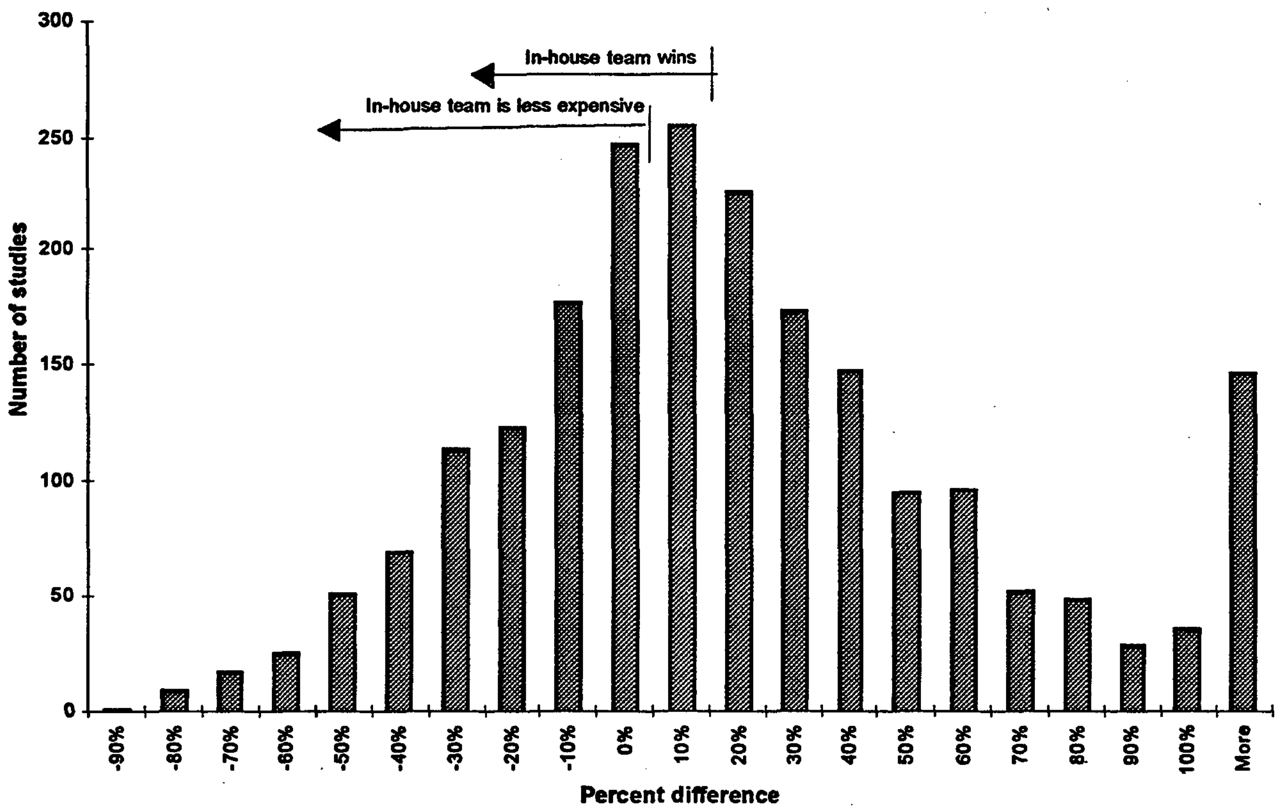
Figure 2 also shows that the in-house bid is often lower than the contractor bid. This histogram shows the percentage difference between the in-house bid and the lowest contractor bid. Each category displays the number of competitions that had a difference in bids between the last category and up to the displayed percentage. For example the height of the bar at -10 percent is the number of competitions with a difference in bids greater than -20 percent but less than or equal to -10 percent.

9. The term "billets" is used generically to refer to military or civilian jobs (spaces).

10. See [15] for a discussion of leveling the field for A-76 cost comparisons.

In all the competitions that are listed at a negative percent difference, the contractor is more expensive. In all cases when the percent difference is greater than zero, the in-house team is more expensive. Even though the in-house team is more expensive between the zero and 10-percent difference categories, it still wins due to the advantage given to the in-house team. Over 57 percent of the competitions fell between 40 percent and negative 10 percent.

Figure 2. Differences in bids between in-house and lowest contractor



Savings by size

Table 2 shows the large number of small studies. Size is measured by the total number of billets. It also shows a decreasing completion rate as the size of a study increases. The percentage of studies with no savings declines dramatically as the size increases. It does appear that the contractor is more likely to win, but the trend in not consistent. Savings per billet also follow no clear trend in this table.

Table 2. Summary of savings from A-76 competitions by size[a]

Size	Total studies	Percent military	Completion rate	Percent contract wins	Percent with 0 savings	Savings per billet
1 to 10	858	11%	0.63	42%	37%	16
11 to 45	908	11%	0.60	57%	14%	17
46 to 75	141	12%	0.54	52%	9%	16
76 to 100	66	14%	0.68	65%	3%	17
101 to 150	57	17%	0.47	47%	4%	19
151 to 200	34	12%	0.52	47%	9%	17
201 to 250	21	22%	0.50	62%	5%	33
251 to 300	13	29%	0.45	62%	0%	15
More than 300	33	42%	0.43	73%	0%	18
Total	2,131	21%	0.59	51%	22%	18

a. Savings/billet are in thousands of FY 1996 dollars per billet.

Competitions can be for one or more functions. Approximately 15 percent are for two or more functions. Table 3 shows the relationship between savings and size for the subset of studies with only one function (the remaining studies are a bundle of two or more functions). The percent savings increases noticeably as the size of the function increases. The savings per billet are also larger.

Savings by function group

Table 4 shows there are large differences in both the savings and completion rates across function groups. For example, Training had a much lower completion rate than average, but about average savings for the studies that were completed.

Table 3. Savings by size for single function studies[a]

Size	Total studies	Single-function studies Percent military	Percent savings	Savings/billet
1 to 10	796	11%	22%	16
11 to 30	633	11%	29%	18
31 to 45	142	9%	32%	18
46 to 75	94	11%	30%	15
76 to 100	42	17%	34%	17
101 to 200	36	25%	42%	23
More than 201	31	46%	41%	24
Total	1,774	23%	34%	20

a. Savings/billet are in thousands of FY 1996 dollars per billet.

Table 4. Summary of savings from A-76 competitions by function group[a]

Function group	Total studies	Percent military	Completion rate	Percent contract wins	Percent with 0 savings	Savings per billet
Social Services	234	12%	0.62	79%	15%	16
Health	31	19%	0.27	23%	42%	8
Intermediate Maintenance	162	46%	0.66	59%	23%	18
Depot Maintenance	9	0%	0.29	0%	33%	9
BOS Multifunction	28	10%	0.67	43%	0%	13
RDT&E Support	12	76%	0.41	75%	8%	69
Installation Services	645	10%	0.69	46%	26%	19
Other Nonmanufacturing	585	23%	0.57	43%	21%	17
Training	8	92%	0.14	50%	0%	17
ADP	95	14%	0.36	43%	34%	11
Manufac and Fabrication	2	0%	0.11	100%	0%	11
RPM	320	8%	0.71	54%	18%	20
Total	2,131	21%	0.59	51%	22%	18

a. Savings/billet are in thousands of FY 1996 dollars per billet.

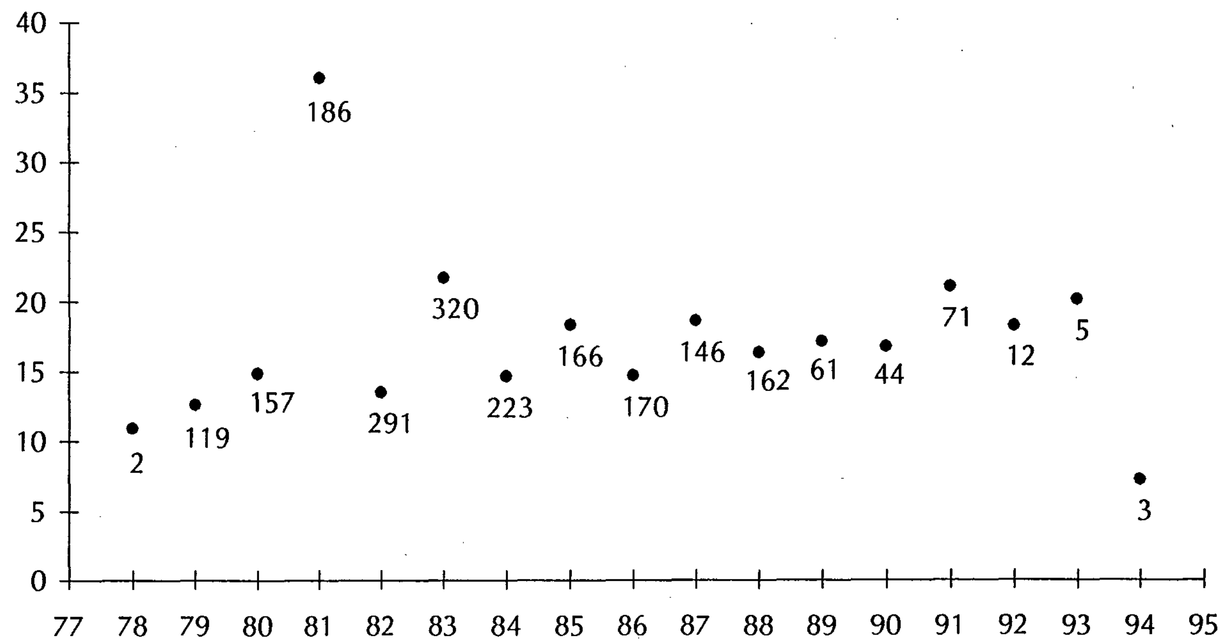
Savings over time

Figure 3 shows the change in savings and number of competitions over time. The number of competitions starts out small at 2 competitions in 1978, then increases to 320 competitions in 1983. After 1983, the number of competitions slowly declines to 162 in 1988. After 1988, the number of competitions drops abruptly to 61 in 1989 and continues to drop to 3 in 1994.

Two policy changes may explain the majority of the reduction in CA studies in the early 1990s. First, in 1990 installation commanders obtained the authority to exempt functions from competitions and to cancel studies with greater discretion. Second, Congress imposed a moratorium in 1992 that required the studies to be finished in a timely manner or be canceled.

Figure 3 shows the savings per billet over time. The savings per billet is usually between $10,000 and $20,000. FY 1994 is low but represents only three competitions. There is no evidence that the savings per billet was decreasing over time as would be predicted if DoD had been "cherry picking" the functions with the most savings to compete first.

Figure 3. Savings per billet over time in FY 1996 dollars[a]



a. The numbers under the data points correspond to the number of competitions that particular year.

Empirical model of savings

Previous CNA studies have modeled and predicted Navy A-76 savings directly [2]. These studies estimate a regression model in which the dependent variable is savings from completed A-76 competitions. Based on the model estimates, predicted savings for each function in the inventory can be obtained directly. The approach does not require an equation to predict baseline cost or who will win the competition as would a model predicting percentage savings or predicting individual bids.

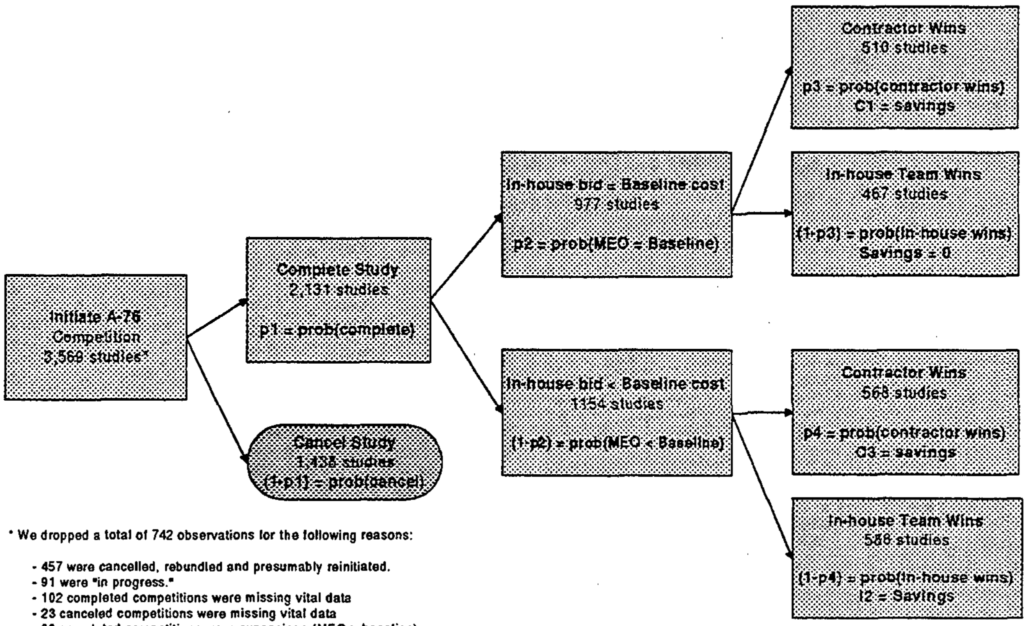
In addition, since the ordinary least squares (OLS) regression goes through the means of the explanatory variables, it will produce a positive predicted savings for all those functions in the inventory that have values for the independent variables close to the means. In this paper, we chose to expand upon the previous regression model of predicting savings as explained below.

A sequential decision tree of A-76 savings

The discussion associated with figure 1 suggests modeling the A-76 process as a sequential decision tree with different expected savings depending on which branch a particular study follows. Given the probability of following each branch, overall expected savings can be calculated as the probability of following each branch times the expected savings from following that branch. This is the approach used here and shown in figure 4.[10]

10. Our other models will be documented later.

Figure 4. Empirical model of A-76 competition savings



* We dropped a total of 742 observations for the following reasons:

- 457 were cancelled, rebundled and presumably reinitiated.
- 91 were "in progress."
- 102 completed competitions were missing vital data
- 23 canceled competitions were missing vital data
- 60 completed competitions were expansions (MEO > baseline)
- 5 canceled competitions were expansions (MEO > baseline)
- 3 had the contractor winning with a higher bid
- 1 was an apparent typographical error

$$E(\text{savings}|\text{complete}) = p_2 \bullet p_3 \bullet C_1 + (1 - p_2) \bullet (1 - p_4) \bullet I_2 + (1 - p_2) \bullet p_4 \bullet C_3$$

The process that ultimately produces observed savings from A-76 competitions involves several steps which we will discuss individually.

The probability of completion

Given that a CA study has been initiated and the scope of work was not increased, the next step is a decision on whether or not to complete the study.[11] Define indicator variable $Y_{1,i}$ such that:

11. In 65 of the 4,311 functions studied since 1979, the scope of work was increased so that the MEO was greater than the baseline number of billets. For these rare cases, it is difficult to define baseline cost since the job being competed has not been previously performed by an in-house team. For this reason, we will not include these cases in the analysis.

$Y_{1,i} = 1$ if the study i is completed

$Y_{1,i} = 0$ if the study i is not completed.

Estimating the probability of completion

The determinants of $Y_{1,i}$ can be estimated with a probit model.[12] Let the probability that $Y_{1,i} = 1$ for function i be denoted by $p_{1,i}$. In the probit model, $p_{1,i}$ is a nonlinear function of a vector of exogenous variables $X_{1,i}$ with the constraint $0 < p_{1,i} < 1$ being imposed on the functional form.

The probit model assumes we have a regression model given by

$$Y_{1,i}^* = \beta'_1 X_{1,i} + u_{1,i} \ , \tag{1}$$

where $u_{1,i}$ is a normally distributed random variable with zero mean and unit variance, β_1 is a vector of unknown parameters to be estimated, and $Y_{1,i}^*$ is not observed. It is common to refer to the variable $Y_{1,i}^*$ as a "latent" variable. What is observed is a dummy indicator variable $Y_{1,i}$ defined by

$$Y_{1,i} = 1 \text{ if } Y_{1,i}^* > 0 \tag{2}$$

$$Y_{1,i} = 0 \text{ otherwise} .$$

From equations (1) and (2), we obtain:

$$\begin{aligned} P_{1,i} &= Prob(Y_{1,i} = 1) = Prob(u_{1,i} > -\beta'_1 X_{1,i}) \\ &= 1 - F(-\beta'_1 X_{1,i}) = F(\beta'_1 X_{1,i}), \end{aligned} \tag{3}$$

where $F(\cdot)$ is the standard normal cumulative distribution function. The unknown parameters in the matrix β_1 can be estimated with a maximum likelihood procedure.

12. See [16 through 20] for a discussion of the probit model and its extensions.

The probability of the in-house bid equaling the baseline costs

For those studies that are completed, the in-house team must decide whether or not to keep the Most Efficient Organization (MEO), which is a major determinant of the in-house bid, at the current number of billets or to lower it. Define the indicator variable $Y_{2,i}$ such that

$Y_{2,i} = 1$ if the in-house bid equals the baseline cost

$Y_{2,i} = 0$ otherwise .

Let the probability that $Y_{2,i} = 1$ for function i be denoted by $p_{2,i}$. If the determinants of $p_{2,i}$ depend on a vector of exogenous variables $X_{2,i}$, a model similar to equation (3) will produce estimates of the unknown parameters in β_2.

The probability of the contractor winning

When $Y_{2,i} = 1$, either the in-house team or the outside contractor is awarded the job. If the in-house team wins, savings will be zero. If the contractor wins, there will be positive savings. Define the indicator variable $Y_{3,i}$ such that

$Y_{3,i} = 1$ if the contractor wins given MEO = baseline

$Y_{3,i} = 0$ if the in-house team wins given MEO = baseline.

Denote the probability that $Y_{3,i} = 1$ as $p_{3,i}$. The unknown parameters β_3 can be estimated with a probit model.

Finally, when $Y_{2,i} = 0$, either the in-house team or the outside contractor is awarded the job. Define the indicator variable $Y_{4,i}$ such that

$Y_{4,i} = 1$ if the contractor wins given MEO < baseline

$Y_{4,i} = 0$ if the in-house team wins given MEO < baseline.

Denote the probability that $Y_{4,i} = 1$ as $p_{4,i}$. The unknown parameters β_4 can be estimated with a probit model.

Expected savings

The above four indicator variables define a sequential decision tree that generates observations on savings from A-76 competitions. There are four different ways to generate observed savings. These are:

1. $Y_{1,i} = 1$, $Y_{2,i} = 1$ and $Y_{3,i} = 0$.

In this case, the in-house team decides to keep the number of billets in its bid at the current level, and it wins the contract. Therefore, observed savings will be zero.

2. $Y_{1,i} = 1$, $Y_{2,i} = 1$ and $Y_{3,i} = 1$.

In this case, the in-house team's bid for the MEO is the same as the current level, but the contractor wins the contract. The observed savings will be positive. Denote these savings as $C_{1,i}$ and assume they are related to a vector of exogenous variables, $Z_{1,i}$, via the stochastic regression equation

$$C_{1,i} = \gamma'_1 Z_{1,i} + \varepsilon_{1,i} \quad , \tag{4}$$

where $\varepsilon_{1,i}$ is a random error term with zero mean and γ_1 is vector of parameters that can be estimated with ordinary least squares on the observed savings.

3. $Y_{1,i} = 1$, $Y_{2,i} = 0$ and $Y_{3,i} = 0$.

In this case, the in-house team's bid contains fewer billets than the current level, and it wins the contract. Again, the observed savings will be positive. Denote these savings by $I_{2,i}$ and assume they are related to a vector of exogenous variables $Z_{2,i}$ via the stochastic regression equation

$$I_{2,i} = \gamma'_2{}' Z_{2,i} + \varepsilon_{2,i} \quad , \tag{5}$$

where γ_2 is vector of parameters that can be estimated with ordinary least squares on the observed savings.

4. $Y_{1,i} = 1$, $Y_{2,i} = 0$ and $Y_{3,i} = 1$.

In this case, the in-house team's bid contains fewer billets than the current level, but the contractor wins the contract. Again, the observed savings will be positive. Denote these savings by $C_{3,i}$ and assume they are related to a vector of exogenous variables $Z_{3,i}$ via the stochastic regression equation

$$C_{3,i} = \gamma'_3 Z_{3,i} + \varepsilon_{3,i} \quad , \tag{6}$$

where γ_3 is vector of parameters that can be estimated with ordinary least squares on the observed savings.

The decision tree that generates the observations on A–76 competition savings is depicted in figure 4. Let S_i be the savings associated with study i. The expected savings for function i drawn randomly from the inventory is

$$E(S_i) = p_{1,i}p_{2,i}p_{3,i}E[C_{1,i}] + p_{1,i}(1-p_{2,i})(1-p_{4,i})E[I_{2,i}] + p_{1,i}(1-p_{2,i})p_{4,i}E[C_{3,i}] \; , \tag{7}$$

where $E[C_{1,i}]$ is the expected savings for function i if the MEO equals the current billets and the contractor wins the bid, $E[\mathbf{I}_{2,i}]$ is the expected savings if the MEO is less than the current billets and the in-house team wins the bid, and $E[C_{3,i}]$ is the expected savings when the MEO is less than the current billets and the contractor wins the bid.

Equation 7 assumes only the proportion $p_{1,i}$ of all A–76 competitions will be completed. If one is interested in computing the potential expected savings assuming all functions in the inventory are studied and completed, this expectation is given by

$$E(S_i \mid \text{i completed}) = p_{2,i}p_{3,i}E[C_{1,i}] + (1-p_{2,i})(1-p_{4,i})E[I_{2,i}] + (1-p_{2,i})p_{4,i}E[C_{3,i}] \; , \tag{8}$$

where all variables are as previously defined.

Empirical estimates

In this section, we will discuss the probit model estimates presented in tables 5 through 8 and the savings equation regression estimates presented in tables 9 through 11. For each empirical examination, we have defined a series of dummy indicator variables $Y_{1,i}$, $Y_{2,i}$, $Y_{3,i}$, and $Y_{4,i}$, as described above.

We are taking an A-76 competition conducted by the Navy for the functions Installation Services, Real Property Maintenance, and Base Operating Support (BOS) as the base case. Hence, we will not define dummy variables for the Navy or for the functions Installation Services, Real Property Maintenance, or BOS. We compare other potential or realized A-76 competitions to this base case. For example, we will compare a competition conducted by the Army for the Health Services function, by the Marine Corps for Social Service functions, and so forth, to the base case.

We also include a number of other variables to explain individual outcomes. Of these, the most important are number of billets, and number of billets squared. The squaring is to take account of potential nonlinear effects of number of billets. There are also a number of function*billets terms, to take account of potential interactions of billets and functions. We also interacted service with billets.

Probit model estimates

Because the probit model is a nonlinear function of the explanatory variables, the marginal effect of a unit change in one of the independent variables on the dependent variable is a complicated function. For example, consider the probit estimates presented in table 5. In this table, the dependent variable is $Y_{1,i}$, where $Y_{1,i} = 1$ if competition i is completed and $Y_{1,i} = 0$ if competition i is canceled.

In the probit model, Prob($Y_{1,i}$ = 1) = $F(\beta' x_{1,i})$, where $F(\cdot)$ is the standard normal cumulative function. Let $X_{1,ki}$ be the kth element of the vector of independent variables $X_{1,i}$ and $\beta_{1,k}$ be the kth element of β_1. Then the marginal effect of a change in a particular variable $X_{1,ki}$ on Prob ($Y_{1,i}$ = 1) is

$$\frac{\partial}{\partial X_{1,ik}} F(X'_{1,i}\beta_1) = f(X'_{1,i}\beta_1)\beta_{1,k} ,$$

where $f(\cdot)$ is the standard normal density function. Since this impact depends on the particular $X_{1,i}$ vector used, unless otherwise noted we will only discuss the direction and not the magnitude of the effect of a change in an independent variable on the Prob($Y_{1,i}$ = 1).

Although there are several measures of goodness of fit for the probit model, none have the same interpretation as the R^2 measure that is common to regression models. For this reason, we will not report R^2 measures for the probit estimates. However, there is a measure of the overall significance of the independent variables in the probit model that is similar to the standard overall F-test in regression models. This is the likelihood ratio test, and it will be reported in all tables of probit model estimates.

The likelihood ratio test is a general large-sample test based on the maximum likelihood (ML) method. Let θ be the set of parameters in the model and $L(\theta)$ be the likelihood function. What the likelihood ratio says is that we first obtain the maximum of $L(\theta)$ with all the independent variables included in the model and then with the restrictions imposed by the overall hypothesis test that none of the independent variables are relevant. We then consider the ratio

$$\lambda = \frac{Max\ \{L(\theta)\} \text{ under the restriction all } \theta_i \text{ except the intercept are zero}}{Max\ \{L(\theta)\} \text{ without the restriction}} .$$

Note that λ will necessarily be less than 1 since the restricted maximum will be less that the unrestricted maximum. If the restrictions are not valid, λ will be significantly less than 1. If they are valid, λ will be close to 1. The LR test consists of using -2 $\log_e \lambda$ as a χ^2 with k degrees of freedom, where k is the number of explanatory variables in the probit model.

Probit 1: The probability of completion

Table 5 examines whether a particular A-76 competition was completed. In this case, as in all other probit and OLS results presented here, our variables are collectively significant. This is tested explicitly by the likelihood ratio test statistics reported for the probit estimates and by the overall F-statistic reported for the regression results. All these statistics are significant, indicating that the independent variables have explanatory power.

Ignoring the effect of billets, table 5 shows that a base case naval competition for Installations Services, Real property Maintenance, or BOS had approximately a .76 probability (76 percent chance) of being completed. This probability is computed as the integral for the normal density function from $-\infty$ to the intercept, which equals .705.

Ignoring the interaction terms, increasing the number of billets tended to decrease the probability of completion (the coefficient on billets is negative). As the number of billets increased for a given competition, the impact of the effect of billets began to lessen very slightly as indicated by the coefficient on the billets squared variable. Over the sample considered, an increase in the number of billets would never have the effect of making completion of a competition more likely.

Marine Corps and DoD agency competitions were significantly less likely than Navy competitions to be completed, all else held equal. There were no significant differences between Navy and the Army or Air Force competitions.

If we choose one branch of the armed forces and a given number of billets, we find that all competitions except Social Services were significantly less likely to be completed than the base case of Installation Services, Real Property Maintenance, and BOS. This effect appears strongest for Manufacturing and Fabrication competitions, as indicated by the -1.94 estimate on this dummy variable. The difference for Social Services competitions is barely significant, which indicates a possibility that there is no real difference between Social Services and the base case (accounting for sample error of the estimates).

Table 5. Probit 1: The probability of completion

Variable name	Estimated coefficient	Standard error	*T*-ratio	*P*-value
Constant	0.705	0.0543	12.980	0.00
Announced billets[a]	-0.00268	0.000774	-3.471	0.00
Announced billets^2	0.00000337	0.000000827	4.074	0.00
DoD agencies	-1.24	0.128	-9.690	0.00
Army	0.0649	0.0705	0.920	0.36
Air Force	0.0579	0.0606	0.955	0.34
Marines	-0.629	0.153	-4.127	0.00
Social Services	0.208	0.0992	2.102	0.04
Other Nonmanufacturing Operations	-0.541	0.0616	-8.789	0.00
Intermediate Maintenance	-0.0466	0.110	-0.423	0.67
Health Services	-1.16	0.201	-5.778	0.00
Automatic Data Processing	-0.964	0.113	-8.501	0.00
Education and Training	-1.84	0.227	-8.100	0.00
Manufacturing and Fabrication	-1.94	0.463	-4.201	0.00
Depot Maintenance	-1.08	0.303	-3.551	0.00
RDT&E Support	-1.03	0.299	-3.452	0.00
DoD agency billets	-0.000529	0.00172	-0.308	0.76
Army billets	-0.000948	0.000713	-1.330	0.18
Air Force billets	0.000368	0.000749	0.492	0.62
Marine billets	-0.00306	0.00205	-1.489	0.14
Social Service billets	-0.00318	0.00110	-2.897	0.00
Other Nonmanufacturing Operations billets	0.00280	0.000876	3.196	0.00
Intermediate Maintenance billets	-0.000851	0.000708	-1.202	0.23
Health Services billets	-0.00634	0.00771	-0.823	0.41
Automatic Data Processing billets	0.00191	0.00265	0.722	0.47
Education and Training billets	0.000619	0.00130	0.476	0.63
Manufacturing and Fabrication billets	0.000536	0.00165	0.326	0.74
Depot Maintenance billets	0.00234	0.00259	0.903	0.37
RDT&E Support billets	0.00335	0.00349	0.958	0.34

a. Announced positions were used instead of baseline billets because baseline billets was missing for many of the canceled studies.

The dependent variable is completion status

Likelihood ratio test: 537.4 w/ 28 df		Actual completion	
		0	1
Predicted completion	0	577	252
	1	861	1879

Percentage of correct predictions 0.688

Holding the branch of service and function type fixed, we find that increasing the number of billets did not change the effect of a particular function on the likelihood of a competition being completed except for Other Nonmanufacturing Operations and Social Services. We thus conclude, for example, that increasing the number of billets for a Navy Depot Maintenance competition would have the same effect as increasing the number of billets in the base case.

There are some odd results that don't have a ready explanation. We find Other Nonmanufacturing Operations less likely to be completed for small competitions. However, if the number of billets is more than 200, Other Nonmanufacturing Operations competitions are more likely to be completed than in our base case.

We found opposite results for Social Service competitions. In Social Service competitions where the number of billets is less than 70, the probability of completion would be greater than in our base case. However, if the number of billets was 70 or greater, Social Service competitions would be less likely to be completed than in our base case.[13]

In summary, larger competitions are less likely to be completed. The Army, Air Force, and Navy don't differ much in number of completions, but they complete more than the Marines and DoD agencies, and there are differences across the different functions.

Probit 2: The probability that MEO equals baseline

Table 6 shows how some characteristics affect the probability that the in-house competitor's bid is the same as the number currently engaged in the task. That is, the dependent variable equals 1 if the in-house team's MEO is the same as the baseline billets and equals zero if the in-house team's MEO was a reduction in baseline billets.

13. This is calculated by comparing -0.003 on the Social Service interaction variable to 0.208 for the Social Service dummy variable.

Table 6. Probit 2: The probability that MEO = baseline

Variable name	Estimated coefficient	Standard error	*T*-ratio	*P*-value
Constant	0.634	0.0725	8.745	0.00
Billet	-0.0139	0.00175	-7.947	0.00
Billet ^{2}	0.00000994	0.00000172	5.777	0.00
Percent military	-0.692	0.141	-4.905	0.00
Military billets	0.00112	0.00194	0.578	0.56
Multifunction	-0.320	0.0890	-3.599	0.00
DoD agencies	-0.660	0.298	-2.216	0.03
Army	-0.442	0.0929	-4.762	0.00
Air Force	-0.280	0.0804	-3.487	0.00
Marines	-0.366	0.315	-1.163	0.24
Social Services	0.229	0.118	1.936	0.05
Other Nonmanufacturing	-0.409	0.0905	-4.524	0.00
Intermediate Maintenance	-0.00789	0.127	-0.062	0.95
Health Services	0.00897	0.238	0.038	0.97
Automatic Data Processing	0.375	0.236	1.587	0.11
Education and Training	-0.468	0.543	-0.863	0.39
Manufacturing and Fabrication	0.810	0.876	0.925	0.36
Depot Maintenance	-0.439	0.519	-0.846	0.40
RDT&E Support	-0.614	0.456	-1.345	0.18
DoD agency billets	-0.0127	0.0145	-0.874	0.38
Army billets	0.00532	0.00171	3.116	0.00
Air Force billets	0.00115	0.00163	0.704	0.48
Marines billets	-0.00962	0.0110	-0.878	0.38
Social Service billets	0.00142	0.00275	0.515	0.61
Other Nonmanufacturing Operations billets	-0.000890	0.00279	-0.319	0.75
Intermediate Maintenance billets	0.000466	0.00136	0.343	0.73
Automatic Data Processing billets	-0.0186	0.0104	-1.785	0.07

The dependent variable is whether MEO = baseline

		Actual Y_2	
Likelihood ratio test: 392.4 w/ 26 df		0	1
Predicted Y_2	0	784	304
	1	370	673
Percentage of correct predictions	0.684		

Our explanatory variables in table 6 change somewhat from table 5. We do not examine interactions of the number of billets with services for Education and Training, Manufacturing and Fabrication, Depot Maintenance, and RDT&E Support. We do add variables to see whether percent of billets that are military has an effect and also to see how this effect interacts with the total number of billets. This interaction term reduces to the number of military billets. We include both these terms to attempt to capture linear and nonlinear effects of the military billets on this probability. We also add a term for Multi-function bids, where two tasks or more are combined into one Request for Proposal, to see whether bundling had a significant effect.

For our base case, ignoring effects of numbers of billets, there was approximately a .73 probability (73 percent chance) that the in-house competitor would not reduce the number of billets for a competition. As before, this probability is computed as the integral for the normal density function from $-\infty$ to 0.634. Here again, ignoring the interaction terms, the effect of increasing the number of billets was to decrease the probability of bidding an MEO equal to baseline billets. This effect tended to lessen as the number of billets increased, but no increase in the number of billets would have made bidding MEO equal to baseline more likely over the sample. Only for a number of billets greater than 1,400 would this occur, as indicated by the -0.014 coefficient on the billets variable and the 0.00001 coefficient on the billets squared variable.

Increasing the percent of military billets tended to lessen the probability of bidding the MEO equal to baseline billets, and this effect did not significantly decrease as the number of billets increased.

Ignoring the interaction terms with billets, the probability of bidding the MEO equal to baseline billets was often significantly different for different branches of the military. The exception to this is the Marines who did not differ significantly from the Navy. The Army and Air Force were significantly less likely to bid the MEO equal to baseline billets, holding all other variables fixed and ignoring the interaction terms. DOD agencies were also significantly less likely than the base case to bid the MEO equal to baseline billets. Bids from bundling, as shown by our Multifunction term, significantly reduced the probability of bidding the MEO equal to baseline billets.

Change in function type did make a significant difference in general for the probability of bidding the MEO equal to baseline billets. The only exception was for Other Nonmanufacturing, where the probability fell significantly.

In general, there were no significant interaction effects between our terms with the number of billets for this probability. The exception here was for the Army. As the number of billets rose, the reduction in probability of bidding the MEO equal to baseline billets between the Army and the Navy, holding function type fixed, tended to evaporate. In cases where the number of billets was greater than 84, the probability that the Army would bid a reduction would be greater than that for the Navy.

In summary, MEOs have been more likely to produce savings in larger activities, especially those with military billets; in the Army, Air Force, and DoD agency competitions; and in multifunctional competitions.

Probit 3: The probability of contractor win given MEO equals baseline

Table 7 looks at the likelihood of a contractor win. This is the same as the probability that the cost of the in-house bid is greater than 1.1 times the relevant contractor bid, for the subset of studies where the Most Efficient Organization equaled the baseline contract case, pursuant to the general guidelines of the A-76 competitions. Here our dependent variable was 1 if the adjusted contractor bid was the lesser, and 0 if the in-house bid was the lesser.

Our variables for this table are the same as those for table 6. For the typical base case, ignoring the effects of billets, the probability that a contractor would win would be about .46 (or a 46 percent chance), as computed from the integral for the normal density function from $-\infty$ to -0.088. Ignoring the interaction terms, at the median level of 14 billets, this probability would be .51.

Table 7. Probit 3: The probability of contractor win given MEO = baseline

Variable name	Estimated coefficient	Standard error	*T*-ratio	*P*-value
Constant	-0.0883	0.0958	-0.922	0.36
Billet	0.00759	0.00383	1.983	0.05
$Billets^2$	-0.00000570	0.00000766	-0.743	0.46
Percent military	0.224	0.256	0.874	0.38
Military billets	0.00644	0.00833	0.773	0.44
Multifunction	-0.318	0.152	-2.095	0.04
DoD agencies	-0.567	0.443	-1.280	0.20
Army	-0.326	0.149	-2.189	0.03
Air Force	0.335	0.130	2.572	0.01
Marines	0.190	0.687	0.276	0.78
Social Services	0.551	0.236	2.338	0.02
Other Nonmanufacturing Operations	-0.350	0.138	-2.538	0.01
Intermediate Maintenance	-0.249	0.189	-1.321	0.19
Health Services	-1.104	0.377	-2.928	0.00
Automatic Data Processing	-0.270	0.297	-0.907	0.36
Education and Training	6.561	5013.8	0.001	1.00
Manufacturing and Fabrication	1.893	7129.1	0.000	1.00
Depot Maintenance	-6.258	3983.2	-0.002	1.00
RDT&E Support	-0.553	0.925	-0.597	0.55
DoD Agency billets	0.0245	0.0327	0.748	0.45
Army billets	0.00348	0.00478	0.729	0.47
Air Force billets	-0.000987	0.00516	-0.191	0.85
Marine billets	-0.137	0.118	-1.157	0.25
Social Service billets	0.00933	0.0183	0.509	0.61
Other Nonmanufacturing Operations billets	0.00874	0.00660	1.325	0.19
Intermediate Maintenance billets	-0.00450	0.00486	-0.926	0.35
Automatic Data Processing billets	0.00764	0.0170	0.450	0.65

The dependent variable is contractor win

Likelihood ratio test: 132.7 w/ 26 df		Actual Y_3	
		0	1
Predicted Y_3	0	303	181
	1	164	329
Percentage of correct predictions	0.647		

As billets increased, the probability of contractors winning tended to increase. There was also a very insignificant nonlinear decrease to this effect. No interaction of billets with any other variable was found to make a significant difference in results.

There were some significant differences between the branches of the military. Contractors were significantly less likely to win for Army tasks. On the other hand, contractors were significantly more likely to win for Air Force tasks. In fact, the quantitative differences between the Navy base case and the Army; and between the Navy base case and the Air Force are almost the same but in opposite directions. The differences in probability for contractor wins between the Navy and the Marines are not significant, and there were no significant differences for DoD agencies either.

For Multifunction tasks, contractors were significantly less likely to be the winners, so again in this case, bundling makes a difference. Contractors were significantly more likely to win for Social Service contracts than for the base case. However, contractors were significantly less likely to win for Other Nonmanufacturing Operations and for Health Services. There were no other significant differences for service types.

Data problems in the form of a limited number of observations for certain functions were relatively severe for this examination, leading to standard errors many orders of magnitude greater than some coefficient estimates for some functions, such as Manufacturing and Fabrication and Education and Training. It is thus possible that additional data might suggest some likelihood of contractors winning for these functions or the converse.

Note that in table 7, the *P*-values are not easy to interpret but the t-ratios are. The fact there are three variables for which the t-values are zero, and only seven variables for which $|t|$ is greater than two, suggests that there might be some data problems. However, the percentage of correct predictions, 0.65, is not bad.

To summarize, in cases where MEOs are equal to the baseline, the probability of the contractor winning is highest in the Air Force and lowest in the Army; there are some differences in contractors winning across functions; contractors are less likely to win multifunctional competitions; and contractors are more likely to win larger activities.

Probit 4: The probability of contractor win given MEO is less than baseline

Table 8 examines probabilities that contractor bids were lower than inhouse bids where the Most Efficient Organization was less than the baseline. The definition for the dependent variable is the same for this table as for table 7, and the conditions under which contractor bids were considered lower, pursuant to regulations governing A-76 competitions, remain the same as well.

The explanatory variables for this table are the same as those in table 7. Contractors were much less likely to win in these circumstances as compared to table 7. For the typical base case under these conditions, ignoring the effects of billets, the probability that a contractor would win would be about .33. This is computed as the integral for the normal density function from $-\infty$ to -0.4425. Ignoring interaction effects, at the median billet level of 14 this probability would be approximately .35.

More of the coefficient estimates are significant for this probit equation, which suggests significant differences among the cases examined. Ignoring interaction effects, as numbers of billets increase, the probability for winning contractor bids relative to the base case increases significantly. For bids of more than 111 billets, the probability of the contractor winning the competition is greater than 50 percent. A quadratic decrease was again indicated for this effect, but this does not have noticeable numerical impact over the sample considered. The coefficient for the interaction variable of billets and military percentage was also significant (military percentage itself was not), suggesting a nonlinear increase in probability of low contractor bids as both military percentage and number of billets are increased. The only significant interaction effects of billets and function was for Social Service billets.

The only significant difference between the base case and those for other branches of the military occurred for the Air Force. Contractors were significantly more likely to win for Air Force tasks. There were no

Table 8. Probit 4: The probability of contractor win given MEO < baseline

Variable name	Estimated coefficient	Standard error	*T*-ratio	*P*-value
Constant	-0.443	0.106	-4.163	0.00
Billet	0.00425	0.00145	2.930	0.00
Billets^2	-0.00000432	0.00000149	-2.900	0.00
Percent military	0.296	0.164	1.799	0.07
Military billets	0.00252	0.00116	2.178	0.03
Multifunction	-0.442	0.107	-4.129	0.00
DoD agencies	0.645	0.683	0.944	0.35
Army	0.190	0.130	1.469	0.14
Air Force	0.534	0.112	4.755	0.00
Marines	0.495	0.314	1.578	0.11
Social Services	1.505	0.229	6.558	0.00
Other Nonmanufacturing Operations	-0.161	0.107	-1.509	0.13
Intermediate Maintenance	0.462	0.183	2.528	0.01
Health Services	-0.669	0.357	-1.874	0.06
Automatic Data Processing	0.117	0.289	0.404	0.69
Education and Training	-0.532	0.650	-0.818	0.41
Manufacturing and Fabrication	5.886	2601.2	0.002	1.00
Depot Maintenance	-5.382	904.1	-0.006	1.00
RDT&E Support	0.465	0.467	0.995	0.32
DoD Agency billets	-0.0616	0.0360	-1.711	0.09
Army billets	-0.000176	0.00132	-0.134	0.89
Air Force billets	-0.00244	0.00143	-1.709	0.09
Marine billets	-0.00119	0.00453	-0.262	0.79
Social Services billets	-0.00463	0.00243	-1.906	0.06
Other Nonmanufacturing Operations billets	0.00120	0.00139	0.864	0.39
Intermediate Maintenance billets	0.000849	0.00144	0.590	0.56
Automatic Data Processing billets	-0.00135	0.00536	-0.252	0.80

Likelihood ratio test: 184.5 w/ 26 df

		Actual Y_4 0	Actual Y_4 1
Predicted Y_4	0	407	221
	1	179	347

Percentage of correct predictions 0.653

significant differences between other branches and the Navy, nor did DoD agencies show significant differences. The effects that were observed would suggest that contractors were more likely to win for all other branches and DoD agencies relative to the Navy. In-house contractors tended to be significantly more likely to win for Multi-function tasks, suggesting a bundling effect for these cases as well.

There were significant differences between the base case and for only two functions: Social Services and Intermediate Maintenance. Ignoring interaction effects, contractors were significantly more likely to win on these services, all else held equal. The difference for Health Services was almost significant, with in-house bids being lower for this function.

There are problems in table 8 similar to those in table 7. The *P*-values are not meaningful, but the *t*-ratios are. The *t*-ratios are almost zero for two cases, but for eight cases we have $|t| > 2$, and the percentage of correct predictions is 0.65. Thus, there are some data problems, but they are not severe.

In summary, in those cases where the MEO is below the baseline, contractors were more likely to win in larger competitions, in Air Force competitions, and in single function competitions.

This completes our discussion of our probit tables. The remaining tables discuss factors affecting observed savings under the various conditions in which they were observed. Each regression for the succeeding table is an OLS regression. Conditional on the case under consideration, R^2's have clear meaning and will be reported in turn. The variables for all these regressions are collectively significant and substantial, but varying proportions of variation are explained for each.

OLS model estimates

The dependent variables for each of the succeeding tables are thousands of dollars saved. Our independent variables remain the same as in the previous tables.

C_1: Savings estimates given the contractor wins and the MEO equals the baseline

Table 9 discusses savings when the Most Efficient Organization equaled the baseline, and the contractor won. Mean savings were $367,000. For the baseline case, we estimate that savings increased as the billets variable increased for small numbers of billets and decreased for large numbers of billets, with maximum savings reached at approximately 2,000 billets. This maximum savings size should be used with caution since the billets^2 variable is insignificant and very few competitions were anywhere near this size.

Increases in the Percent Military tend to decrease savings in this case, but the effect is counteracted by the the effect of the number of military billets. The total effect, for a typical study, was for savings to increase faster for competitions with more military billets.

There were no significant differences in savings between branches of the military and DoD agencies when compared to the Navy. However, contractor savings for the Air Force were almost significantly different. The Multifunction coefficient was not significant or of great magnitude here, so bundling does not appear to be relevant for these cases.

Some differences in savings were evident for different functions. Ignoring interaction effects, for a given number of billets, savings were significantly less for Social Services and Other Nonmanufacturing Operations than for the base case, and enormously more (over $2 million) for Manufacturing and Fabrication than for the base case. These effects were significantly counteracted in some cases as the number of billets was allowed to increase. As the number of billets increases, there is a significant interaction with the Air Force and savings tended to increase.

C_3: Savings estimates given the contractor wins and the MEO is less than the baseline

Table 10 discusses savings when the Most Efficient Organization was less than the baseline and the contractor won. The mean of these savings was substantially more, $1.7 million.

Table 9. C_1: Savings when MEO = baseline and contractor won

Variable name	Estimated coefficient	Standard error	*T*-ratio	*P*-value
Constant	115.16	29.06	3.962	0.00
Billet	9.105	0.973	9.359	0.00
$Billet^2$	-0.00227	0.00128	-1.775	0.08
Percent military	-296.4	70.03	-4.233	0.00
Military billets	21.4	1.61	13.310	0.00
Multifunction	-28.7	45.6	-0.631	0.53
DoD agencies	-10.04	106.2	-0.095	0.92
Army	0.785	48.2	0.016	0.99
Air Force	53.49	34.5	1.551	0.12
Marines	-64.19	336.4	-0.191	0.85
Social Services	-164.97	41.6	-3.968	0.00
Other Nonmanufacturing Operations	-149.61	44.6	-3.352	0.00
Intermediate Maintenance	-49.97	55.0	-0.909	0.36
Health Services	-186.48	155.4	-1.200	0.23
Automatic Data Processing	-92.14	102.8	-0.896	0.37
Education and Training	-83.83	189.5	-0.442	0.66
Manufacturing and Fabrication	2525.8	337.9	7.475	0.00
RDT&E Support	-159.23	272.7	-0.584	0.56
DoD Agency billets	8.276	5.43	1.523	0.13
Army billets	-1.68	1.28	-1.313	0.19
Air Force billets	2.891	1.16	2.498	0.01
Marine billets	17.34	81.4	0.213	0.83
Social Services billets	7.170	1.88	3.808	0.00
Other Nonmanufacturing Operations billets	3.035	1.74	1.742	0.08
Intermediate Maintenance billets	-5.41	0.440	-12.300	0.00
Automatic Data Processing	-3.86	5.64	-0.684	0.49

The dependent variable is Savings	
R^2	0.484
F (25, 484)	166.0

Table 10. C_3: Savings when MEO < baseline and contractor won

Variable name	Estimated coefficient	Standard error	*T*-ratio	*P*-value
Constant	182.4	464.2	0.393	0.69
Billet	30.3	5.68	5.332	0.00
$Billet^2$	-0.0039	0.0053	-0.729	0.47
Percent military	-203.3	625.6	-0.325	0.75
Military billets	9.08	3.68	2.468	0.01
Multifunction	-799.5	469.6	-1.703	0.09
DoD agencies	225.8	1859	0.122	0.90
Army	269.6	556.0	0.485	0.63
Air Force	-284.6	454.2	-0.627	0.53
Marines	201.3	1178	0.171	0.86
Social Services	-311.7	677.8	-0.460	0.65
Other Nonmanufacturing Operations	-533.9	444.0	-1.202	0.23
Intermediate Maintenance	792.9	609.1	1.302	0.19
Health Services	-915.6	1,839	-0.498	0.62
Automatic Data Processing	-318.3	1,247	-0.255	0.80
Education and Training	-9,525.7	3,211	-2.967	0.00
Manufacturing and Fabrication	-1,121.0	3,637	-0.308	0.76
RDT&E Support	4,064.8	1,343	3.027	0.00
DoD agency billets	-5.19	122.8	-0.042	0.97
Army billets	-1.24	5.29	-0.235	0.81
Air Force billets	7.48	2.91	2.571	0.01
Marine billets	-6.87	13.7	-0.502	0.62
Social Services billets	-12.1	8.40	-1.436	0.15
Other Nonmanufacturing Operations billets	0.988	4.96	0.199	0.84
Intermediate Maintenance billets	-18.6	3.78	-4.922	0.00
Automatic Data Processing billets	-10.5	19.3	-0.542	0.59

The dependent variable is Savings	
R^2	0.481
F (25, 842)	20.3

The direct effects of the Billets variable, ignoring interactions and considering only the Navy base case, are qualitatively similar to those in table 9. However, there are large differences in the coefficients for the Billets variable in table 10 when compared to table 9, and the Squared Billets effect is clearly not significant in table 10.

The effect of Percent Military and Percent Military*billets on savings is the same as in table 9 as well. Coefficients for both variables are significant; the latter is especially so.

There were no significant military branch differences in savings, and the difference between the base case and that for DoD agencies was not significant. The magnitude of the Multifunction (or bundling) coefficient was substantial but insignificant (although nearly significant), suggesting a bundling decrease in savings, all else held equal.

We observed few significant direct function differences in savings. The two cases where the differences were significant were for Education and Training and for RDT&E Support. In the several millions of dollars for each case, there was a reduction in savings versus the base case for the first and an increase versus the base case for the second. Billets did not generally change these effects through interaction. However, the coefficient was significant for Intermediate Maintenance interaction and for the interaction with the Air Force.

I_2: Savings estimates given the in-house team wins and the MEO was less than the baseline

Table 11 discusses savings where in-house team won and the Most Efficient Organization was less than the baseline. The effects observed showed a relatively consistent pattern. Mean savings for this case were $598,500.

The direct effect of Billets was to increase savings both linearly and quadratically. Coefficients for both were strongly significant. Neither Percent Military nor Percent Military*billets made significant differences in savings relative to the base case.

Ignoring interaction effects, military branch differences were relevant. The coefficient for DoD agencies was insignificant, as was that for the Marines, suggesting the differences in savings between these branches and the Navy were insignificant, all else held equal. On the other hand, savings for Army and Air Force tasks tended to be significantly greater than those for the Navy. These differences in savings tended to fall significantly as the number of billets increased for

Table 11. I_2: Savings when the MEO < baseline and the in-house team won

Variable name	Estimated coefficient	Standard error	*T*-ratio	*P*-value
Constant	18.9	64.7	0.292	0.77
Billet	12.1	0.965	12.500	0.00
$Billet^2$	0.00286	0.00114	2.500	0.01
Percent military	-91.3	117.2	-0.779	0.44
Military billets	1.22	1.17	1.042	0.30
Multifunction	150.8	64.8	2.329	0.02
DoD agency	135.0	222.3	0.607	0.54
Army	195.3	80.9	2.415	0.02
Air Force	158.8	75.3	2.109	0.04
Marine	32.2	278.4	0.116	0.91
Social Services	-155.3	208.9	-0.744	0.46
Other Nonmanufacturing Operations	-118.3	68.1	-1.738	0.08
Intermediate Maintenance	-58.3	136.2	-0.428	0.67
Health Services	-210.6	189.1	-1.114	0.27
Automatic Data Processing	65.0	180.7	0.360	0.72
Education and Training	-24.7	315.7	-0.078	0.94
Depot Maintenance	55.6	286.1	0.194	0.85
RDT&E Support	302.4	431.4	0.701	0.48
DoD agency billets	-6.42	2.56	-2.510	0.01
Army billets	-2.10	1.01	-2.073	0.04
Air Force billets	-3.39	1.21	-2.806	0.01
Marine billets	-3.58	5.49	-0.652	0.51
Social Services billets	-0.792	1.95	-0.406	0.68
Other Nonmanufacturing Operations billets	1.49	1.02	1.465	0.14
Intermediate Maintenance billets	1.50	0.983	1.530	0.13
Automatic Data Processing billets	-9.62	3.78	-2.544	0.01

The dependent variable is Savings	
R^2	0.785
F (25, 560)	82.8

each branch by comparable amounts as indicated by the respective coefficients for the Army and Air Force interaction terms of -2.0985 and -3.3853. This interaction effect with Billets was significant for DoD agencies as well.

Ignoring interaction effects, no coefficient for differences in function was significant, suggesting no substantial differences in savings by function, all else held equal. Only for Automatic Data Processing and RDT&E Support was there any suggestion of increased savings over the base case. For all other functions, savings were the same or less than the base case. There was a significant interaction effect for Automatic Data Processing and Billets, suggesting that whatever difference there was between the base case and that for Automatic Data Processing tended to be reduced as the number of billets increased.

Summary of empirical estimates

It is difficult to draw general conclusions for tables 5 through 11 as a whole. Their role will be to predict overall savings. Size of the competition matters, but in nonlinear ways. In general, larger competitions are more likely to be canceled, but they also produce the biggest savings.

Another relevant general conclusion concerns military branch differences. Only in table 5 was the Marine variable significant. This suggests that once a competition occurs, the significant differences in savings and the likelihood of winning will be found between the Navy and Marines on one side and the Army and the Air Force on the other. This does not translate into direct guidance for particular tasks. Outcomes in the various tables for the Air Force coefficient in particular varied substantially from table 6 to table 11. But it does suggest that further examination of these military-branch differences to identify relevant factors may be fruitful.

Finally, the Multifunction variable was significant in numerous tables. Roughly speaking, it tended to increase the likelihood that in-house would win contracting bids, to increase savings if in-house did win, and decrease savings if contractors won, though this last effect was not significant. This suggests that information asymmetries are relevant for the contracting process, and that they have real effects on both costs and bidding strategies.

Predicted savings

As shown in figure 4, we can calculate the expected value of savings for a completed study from the empirical results just presented. We used this method to calculate the expected savings for competing the entire 1995 CA Inventory. The 1995 CA Inventory in table 12 represents 389,090 civilian and military billets (64 percent are civilian). There are 13,382 individual functions spread across DoD with an average size of 29 billets (142 distinct function titles spread across 4,977 distinct locations).

Table 12. 1995 DoD commercial activities inventory by military service over function groups

Function group	DoD agencies	Army	Air Force	Marine Corps	Navy	Total
Social Services	12,990	4,066	2,771	980	5,967	26,774
Health		33,826	3,356	57	27,613	64,852
Intermediate Maintenance	145	4,135	8,858	622	21,574	35,334
Depot Maintenance	316	10,393	871	2,157	30,132	43,869
BOS Multifunction		844				844
RDT&E Support		571	4,021		4,156	8,748
Installation Services	25,208	17,119	16,007	7,959	23,809	90,102
Other Nonmanufacturing	15,714	12,991	4,410	3,212	21,190	57,517
Training	77	1,904	3,893	1,602	16,777	24,253
ADP	3,060	5,329	703	763	4,650	14,505
Manufac. and Fabrication	586	2,754		10	575	3,925
RPM	429	5,099	4,199	1,730	6,910	18,367
Total	58,554	99,031	49,089	19,092	163,353	389,090

Table 13 summarizes our predicted savings for competing the entire 1995 DoD CA Inventory. The blanks in the table stand for functions that do not show up in the inventory, and the zeros stand for functions that have zero predicted savings.[13] These predictions assume that all the studies are completed. However, these estimates

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are not necessarily an upper bound on savings, since the CA Inventory may not capture all the candidates for competition and savings per billet competed could be larger than in the past.[14]

Table 13. Predicted annual savings for the 1995 CA inventory by function assuming all competitions are completed[a]

Function group	DoD agencies	Army	Air Force	Marine Corps	Navy	Total
Social Services	114	63	13	11	80	281
Health		579	26	0	555	1,160
Intermediate Maintenance	1	16	90	2	251	360
Depot Maintenance	2	42	11	21	63	140
BOS Multifunction		20				20
RDT&E Support		39	613		77	729
Installation Services	242	433	464	208	463	1,808
Other Nonmanufacturing	119	241	47	49	425	881
Training	0	0	0	6	169	175
ADP	3	71	5	8	35	123
Manufac. and Fabrication	9	66		3	41	119
RPM	7	117	99	35	137	396
Total	498	1,686	1,368	345	2,297	6,193

a. Savings are in millions of FY 1996 dollars.

The predicted savings presented here are larger than the savings predicted in the companion document [8]. The results presented there do take account of differences in savings by service and function group, but the predicted savings presented here also account for other study characteristics such as differences in the percent of military billets and nonlinear size effects.

13. In some cases, the expected value of savings was negative. In these cases, expected savings were set equal to zero.

14. One reason savings may be higher is that DoD may be able to learn from past experiences competing CA functions and improve the process. This may explain the apparent upward slope in figure 3.

The large potential savings in installation services are not surprising. This area saw large savings in the past and also represents a large portion of the 1995 inventory. Health is also an area with large savings potential, even though the savings per billet competed previously have been low.

The differences across services are primarily due to differences in the level and make-up of their respective inventories. The different inventory practices across services may distort true savings potential across services. See [7, 9] for a discussion of inventory differences.

Table 14 presents the same savings from table 13 by the reason code used to justify not competing the function. This allows us to see the potential savings that are being prevented for each reason code. This can be viewed as the opportunity cost of using the reason codes.

Table 14. Predicted annual savings for the 1995 CA inventory by reason previously given for not competing (also assuming all competitions are completed)[a]

Reason code	DoD agencies	Army	Air Force	Marine Corps	Navy	Total
National defense	7	84		31	120	242
Training or experience (rotation and sea/shore)	0.3	54		86	974	1,115
Unacceptable delay or disruption	5	11	1	0.01		17
No commercial source		3	19	0		22
Government is low cost	4	44	32	9	0	89
Cost comparison is scheduled	221	17	107	5		350
Conversion in progress		4		1		6
Patient care in DoD hospital			1			1
Converting to contract (noncost reason)		0.3	2	17		19
Other					0	0
Review in progress (base closure, etc)	1	807	82		998	1,888
RTD&E exempted function					13	13
Approved as governmental					0.2	0.2
Installation commander decision	161	104	488	5		758
Cost study exceeded time limit	11	202	6	96		315
Exempted by higher authority or law	88	347	630	94	193	1,351
Other or missing		8				8
Total	498	1,686	1,368	345	2,297	6,193

a. Savings are in millions of FY 1996 dollars.

The only reason code outside of the control of DoD is the last one, "exempted by higher authority or law." Even this reason is subject to interpretation, as evidenced by the large cross-service differences. The large savings for the Navy in "training or experience" represent the Navy's sea/shore rotation policy. Possibilities for outsourcing billets in this category are discussed in our work with the Navy CA program [2].

The "review in progress" category is primarily due to BRAC actions. DoD may want to reconsider exempting these billets from study. While the ongoing review may complicate a study, it may also be a case where the transition to an MEO or contractor performance would be less troublesome. For example, if the function has moved locations, there may be many vacant positions. Transitioning with vacant positions would be easier than filling the positions first and then initiating a CA study.

The "installation commander's decision" may represent cases where savings are not being achieved due to bad incentives. In the past, most of the costs associated with an A-76 study were incurred at the installation level while the savings were taken at a higher level. If the installation was allowed to share some of the savings, it might use A-76 as a tool rather than treating it as an unpleasant required task.[15]

Table 15 shows the predicted savings adjusted for the probability of being completed. The probability of being completed is based on the model presented in table 5. This shows the large cost of not completing studies. For example, the predicted savings for the health category drop from $1.2 billion to $43 million. This is due to the very low completion rate for health competitions in the past. This table suggest the need to monitor competition cancellations closely.

As the Navy and DoD embark on a new round of A-76 competitions, they should be aware of their past experiences as a guide for maximizing savings and avoiding past mistakes. They should also be more careful about collecting new data as suggested in [7, 8]. Part of this data collection effort should be a reexamination of the billets

15. Incentives in the A-76 process are also discussed in [2, 15].

classified as inherently governmental. There is strong evidence that potential savings could be almost double what is presented here if all the services are agressive in pursuing competition candidates.[16]

Table 15. Predicted annual savings from competing the 1995 CA inventory (historical completion rate)[a]

Function group	DoD agencies	Army	Air Force	Marine Corps	Navy	Total
Social Services	31	48	10	4	60	154
Health		23	4	0	15	43
Intermediate Maintenance	0.2	10	56	0.4	154	220
Depot Maintenance	0.1	19	5	1	44	70
BOS Multifunction		11				11
RDT&E Support		18	258		40	316
Installation Services	88	327	333	59	325	1,132
Other Nonmanufacturing	88	144	28	12	291	564
Training	0	0	0	0.003	34	34
ADP	1	28	2	1	14	46
Manufacturing and Fabrication	0.04	12		0.1	4	16
RPM	2	86	75	11	91	265
Total	211	728	772	89	1,071	2,871

a. Savings are in millions of FY 1996 dollars.

16. See [9] for details.

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